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GEOLOGY OF PART
OF THE
CENTRAL ST. ELIAS RANGE,
ALASKA-YUKON TERRITORY:
MOUNT VANCOUVER IN PARTICULAR

By Noel E. Odell

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GEOLOGY OF PART OF THE CENTRAL ST. ELIAS RANGE, ALASKA-YUKON TERRITORY: MOUNT VANCOUVER IN PARTICULAR

By Noel E. Odell

PREFACE

This monograph, prepared some years ago, but not published at the time through a series of mischances, as well as service abroad, I have decided to print now in the hope that it may provide some interesting information for a few professional friends and others. Dr. Walter Wood, of the American Geographical Society, assures me that my findings have not been superseded, and, after consulting past numbers of relevant journals, I have myself come to the same conclusion.

Through the kind provision of Dr. Walter Wood, I have perused the excellent series of scientific results recorded by him and his colleagues in the four volumes of "Icefield Ranges Research Project", which cover a wide area of investigations in and beyond the region under discussion. These four volumes were jointly published between 1969 and 1974 by the American Geographical Society and the Arctic Institute of North America, and are a monument of industry and team-work. In Volume 4 (1974) appeared a paper by Michael L. Page on "A Petrographic Study of Mount Logan, Yukon"; but other than this, and an earlier paper (1943 and Vol.3), by Professor R.P. Sharp, entitled "Geology of the Wolf Creek (later Steele Creek) Area, St. Elias Range", the remaining papers are not geological, but cover wide studies in glaciology, associated meteorology and climatology, as well as the biological sciences. Glaciological considerations had been much stimulated by the remarkable advances ('surges') made by some of the glaciers in the area, particularly the Steele Glacier during the late 1940's to 1968. Incidentally, the present writer made a spectacular helicopter flight in April 1977 over the Steele Glacier, and in spite of a large amount of late winter snow-covering, there appeared to be no revival of surging in the main body of ice.

Finally, the writer is fully aware of the late appearance of this paper, which has been the result of various appointments, academic and otherwise, abroad in recent years, as well as of prolonged family illness and other difficulties at home. But as a mountaineer-geologist in this fascinating region, he was privileged to make observations and collect material at some of the higher altitudes, so that travellers and climbers, as well as geologists, may perhaps find here something to interest them.

EARLIER WORK

In Vol.254 of the American Journal of Science (February 1956) appeared an article on "Some Rocks of the Central St. Elias Mountains, Yukon Territory, Canada", by Robert P. Sharp and George P. Rigsby. This was based on observations made during an expedition of the Arctic Institute of North America, primarily for glaciological studies from an advanced base on the upper Seward Glacier, during the summers of 1948 and 1949. This glacier, or névé basin (sensu stricto), is surrounded by high mountains and has many scattered nunataks, or rock islands, especially round its periphery. Materials collected from the latter outcrops constituted almost the entire data reported. It was shown moreover, that the extreme easterly end of the upper Seward intermontane basin is composed predominantly of a pre-Lower Cretaceous (Palaeozoic?) metamorphic series, on which rest Lower Cretaceous calcareous greywacke, sandy limestone, calc quartzite and conglomerate, for which fossil evidence of age was discovered. An earlier phase of intrusives (now meta-diorite) was found to cut the metamorphics, but not the upper sedimentary beds; and a later phase, consisting of quartz-diorite and of lamprophyre, intruded all formations.

SUBSEQUENT WORK

The writer accompanied the second expedition of 1949, known as "Project Snow Cornice", and he was able to add some further observations in the vicinity particularly of Mount Vancouver, 4788.5m., at the extreme eastern end of the upper Seward névé. Here too he was concerned, at an early stage, with three other members of the expedition in the ascent of this unclimbed peak of major alpine proportions. Later, many of the scattered nunatak outcrops were also examined, and findings checked against those of Sharp and Rigsby of 1948. In addition, a brief visit was subsequently made to outcrops some 30 to 40 miles further west on the Seward névé towards the Columbus Saddle, and also along the great southern face of Mount Logan (6054.3m.); but the exigences of other expeditionary obligations unfortunately prevented more than a quick reconnaissance. As a preliminary measure, and when en route to an appointment in New Zealand, the writer published a "short communication" in the Quarterly Journal of the Geological Society, Vol.106, p.137-9, 1951, entitled "Notes on the Geology of the St. Elias Range, Alaska – Yukon Territory, North America." In this an outline only was given of the chief formations of the district, the principal petrographic types, and the general structural relations. Moreover, these present notes are intended as a supplement only to the observations of Sharp and Rigsby, since much of our field-work overlapped.

GENERAL

The bedrock outcrop map, along the eastern and north-eastern margin of the upper Seward Glacier, was shown by Sharp and Rigsby, 1956 (Fig.1) to contain five principal belts ('units') of sedimentary rocks, four of which are metamorphic and of variable composition. These extend upwards from dominant biotite-gneiss (in depth) to meta-diorite, lying in all probability unconformably below the early Lower Cretaceous formation. Two separate phases of igneous rocks, acid and basic, were found to intrude the whole succession, as cited above. Such sampling of the nunataks as the writer was able to carry out confirmed in general the findings of Sharp and Rigsby, with one or two minor exceptions only, and it is unnecessary to duplicate their account. If reference be made to their map (Fig.1), it will be seen that the boundaries of the principal belts of petrographic types, or 'Units' of Sharp and Rigsby, course across the map from N.W. to S.E. While this would seem in general to conform with the grain of the country, from the writer's findings in the field the actual boundaries of these petrographic units are somewhat too rigidly or arbitrarily defined, since some of the rock-types appear anomalously on the wrong side of their supposed boundaries. This, however, probably occurs in only minor degree, and is difficult in any case to determine precisely under the prevailing conditions of glacial cover. It is the area bordering this on the north-east with which we are now concerned, *viz* that lying partly within and partly beyond Sharp and Rigsby's Unit IV, which was considered by them to consist in general of meta-diorite. The principal rocks of this Unit were stated by them to be "a uniform medium – to coarse-grained hornblende-gneiss and a quartz-hornblende-gneiss that can be regarded as metamorphosed diorite and quartz-diorite." A modal analysis (500 counts) of one specimen from Hubbard Col (N.W. of Mount Vancouver) gave 39% quartz, 46 plagioclase, probably oligoclase, 10 biotite, 3 hornblende, 0.5 apatite, 0.5 magnetite, and traces of zircon and zoisite. They added that small to moderate-sized bodies of amphibolite and meta-sedimentary gneiss in Unit IV probably represented inclusions in the original rock. The gneiss also contained small dykes and pods of alaskite, in places pegmatitic, which look to be pre-metamorphic and are probably related to original dioritic intrusive. Epidote veinlets were also found to be abundant.

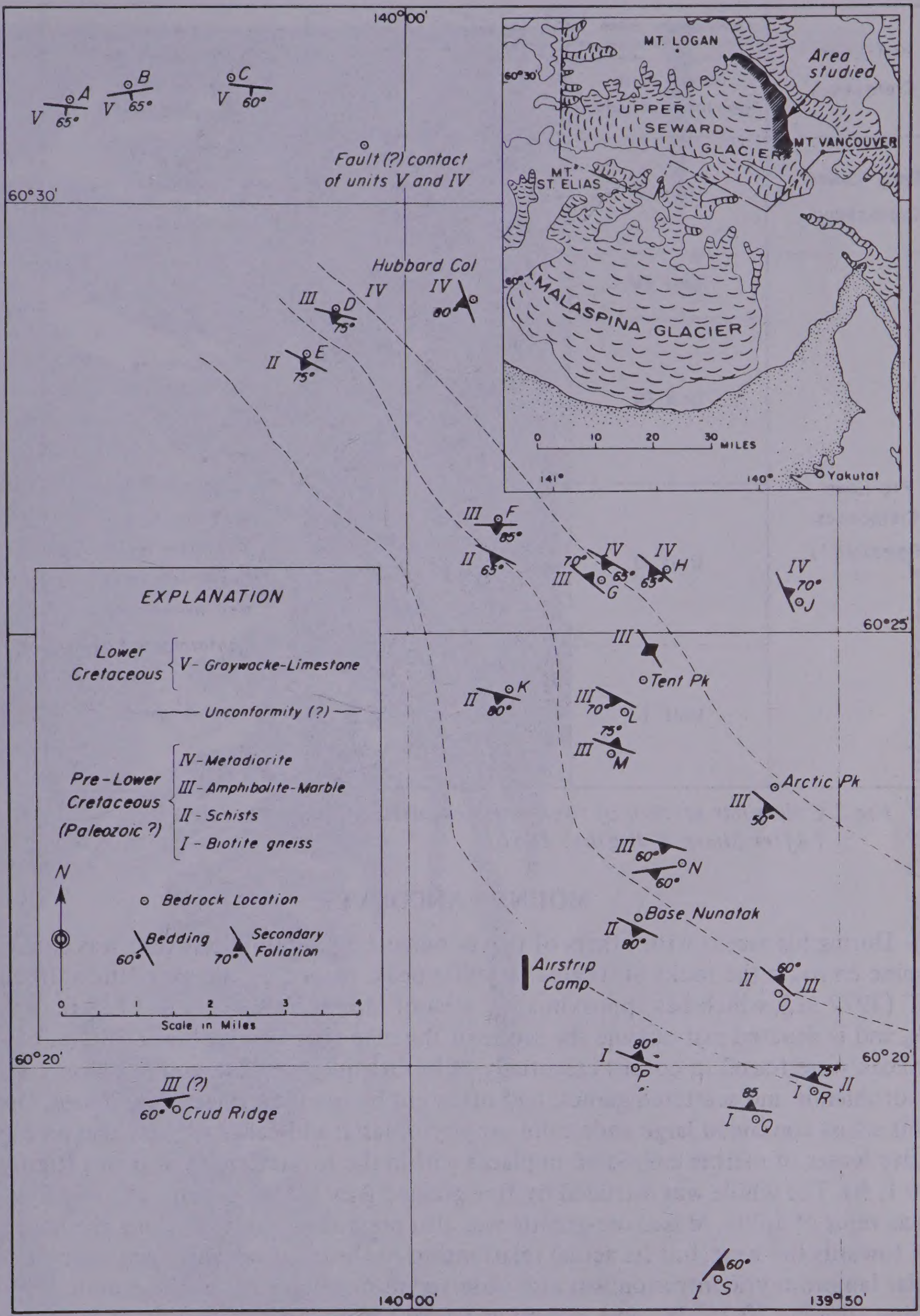

Fig. 1. Bedrock outcrop map along eastern and northeastern margin of upper Seward Glacier. [After Sharp & Rigsby, 1956.]

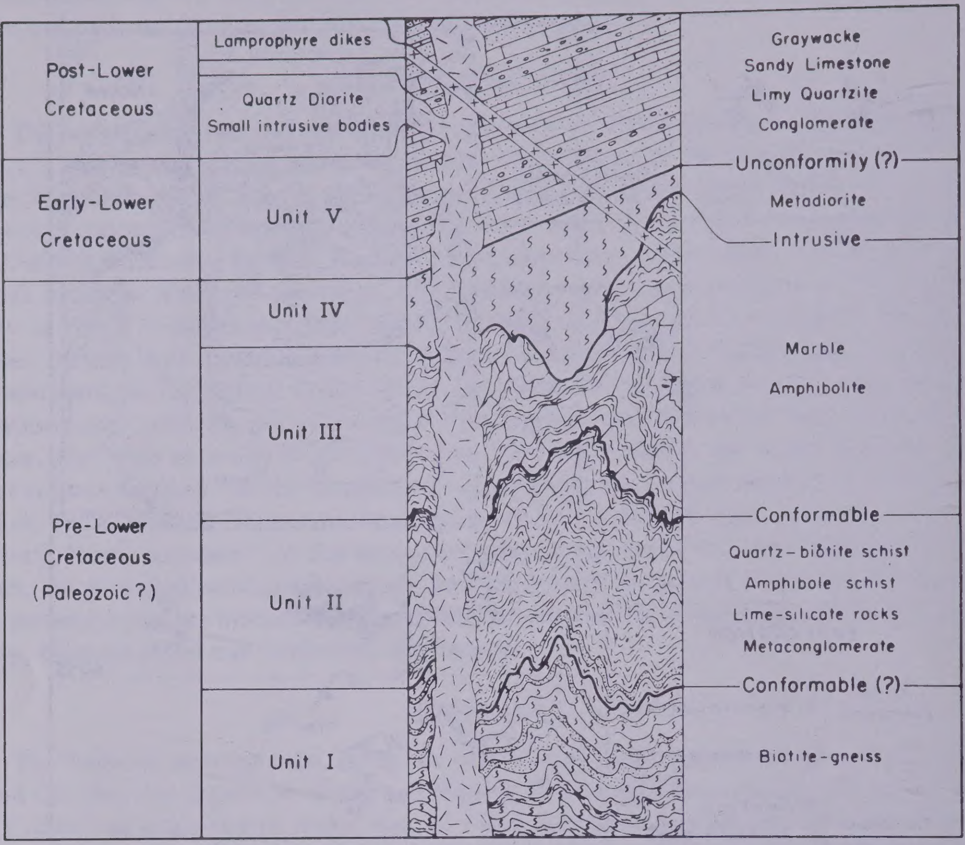

Fig. 2. Columnar section of rock-units exposed in map area (fig. 1). [After Sharp & Rigsby, 1956.]

MOUNT VANCOUVER

During his ascent with others of this dominant mountain, the writer was enabled to examine en route the rocks of its great satellite peak, named by the expedition 'Institute Peak' (3977 m.), which lies approximately west of Mount Vancouver and E.S.E. of Arctic Peak, and is situated just outside the scope of the map (Fig.1). The lower 330 m. of Institute Peak were found to consist essentially of biotite-quartz-schist, and in places containing hornblende and scattered garnet, and often cut by quartz stringers and lenses. One phase of this schist contained large andalusite porphyroblasts; and calc rock was also present, with massive lenses of marble embodied in places within the formation. (Sharp and Rigsby, 1956, Plate 1, B). The whole was intruded by fine-grained grey biotite-granite sills and dykes, as well as veins of aplite. Muscovite-granite was also present in outcrops along the base of the peak towards the west, but its actual relationship to the biotite-granite was obscure. An irregular lamprophyric intrusion was also observed at one place to cut the granite. Pronounced jointing, dipping 70-75° W., and at right angles to the prevailing foliation of the series, cut the whole formation.

Regarding the upper part of Institute Peak, whose eastern shoulder extended into Mount Vancouver itself, the bulk of the formation, where visible and unobscured by snow or ice, consisted of biotite and hornblende-schist and other metamorphic types, approximating to metadiorite, such as described by Sharp and Rigsby, and cited by M.M. Miller during his partial ascent of the peak in 1948.

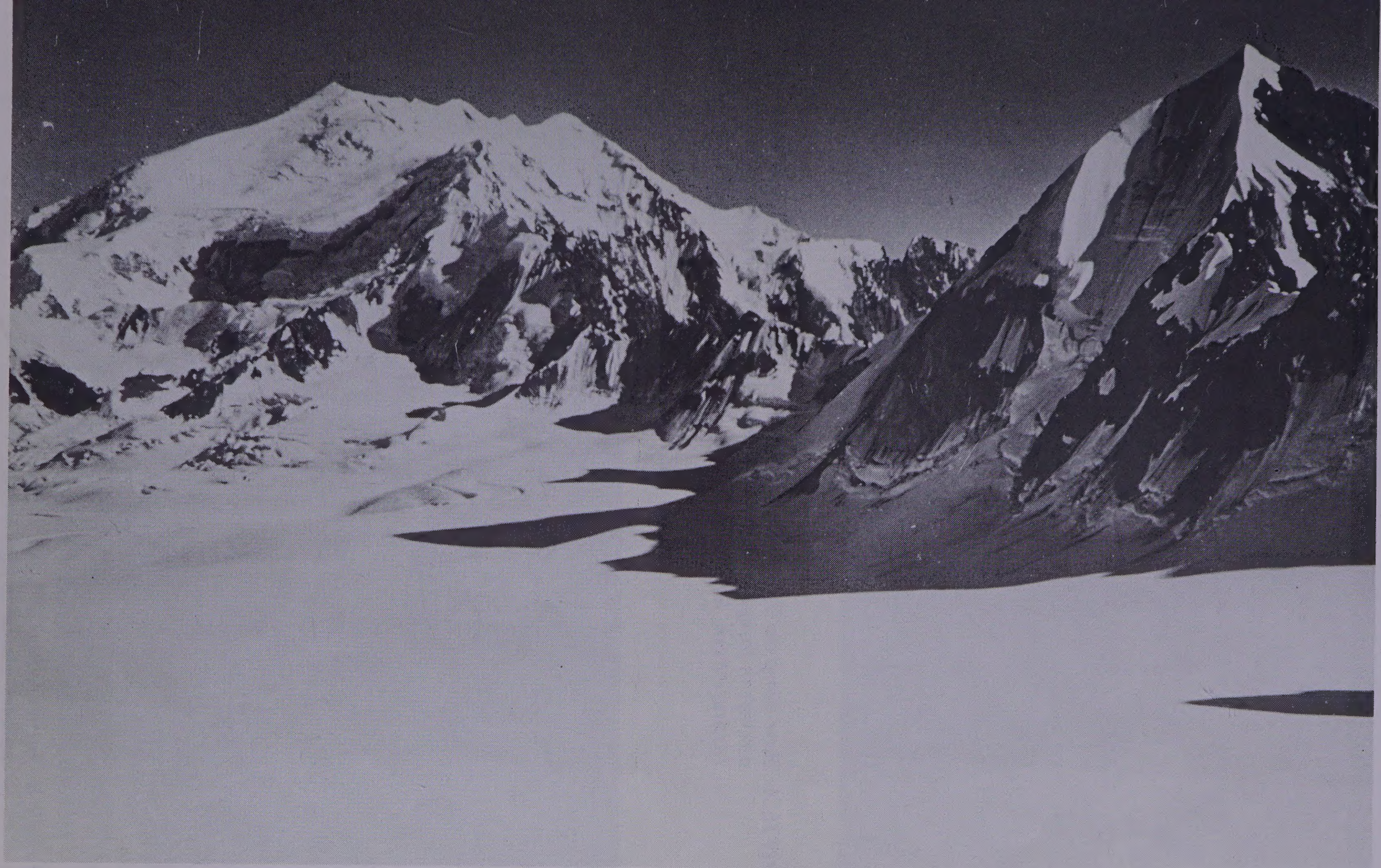

Plate I. Mt. Vancouver from the north-west. ~~Arctic~~ Peak on right, unnamed.
[Photo by R.P. Sharp.]

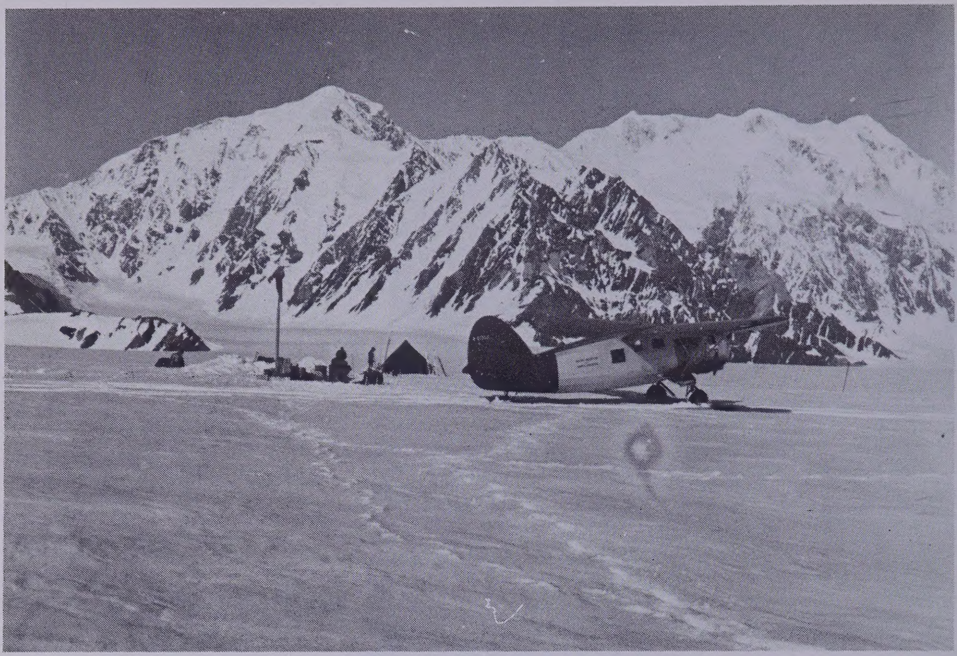

Plate II. A. Base camp on Upper Seward Glacier (ca. 1830 m.). "Norseman" aircraft in foreground. Mt. Vancouver (4788 m.) right background. Institute Peak, left background.

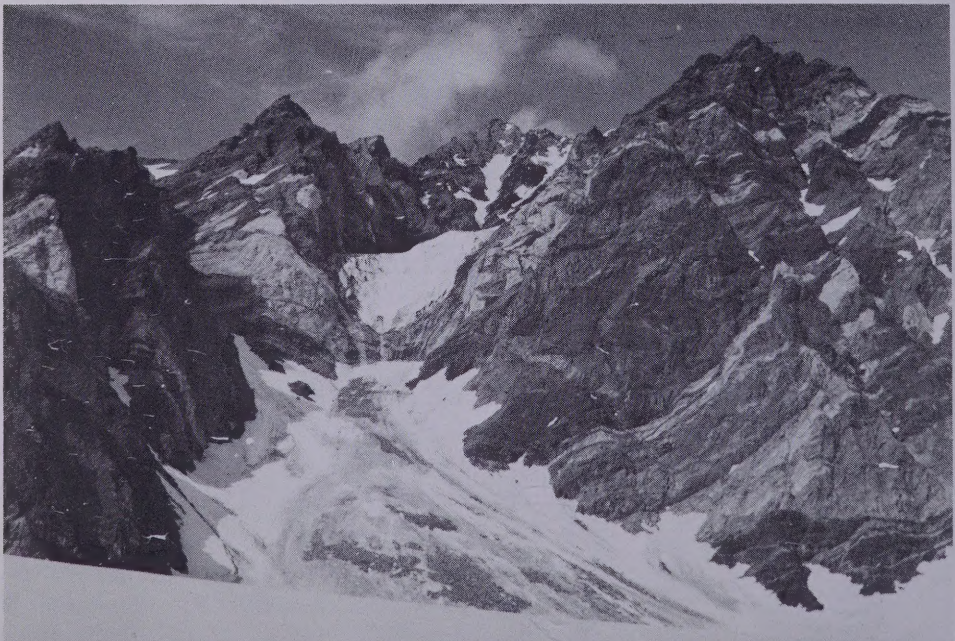

Plate II. B. Institute Peak (W. face). Shows contorted pelitic series. Note hanging glacier in high corrie.

Plate III. A. Mt. Vancouver, E. Peak and Camp III, at 3812 m.

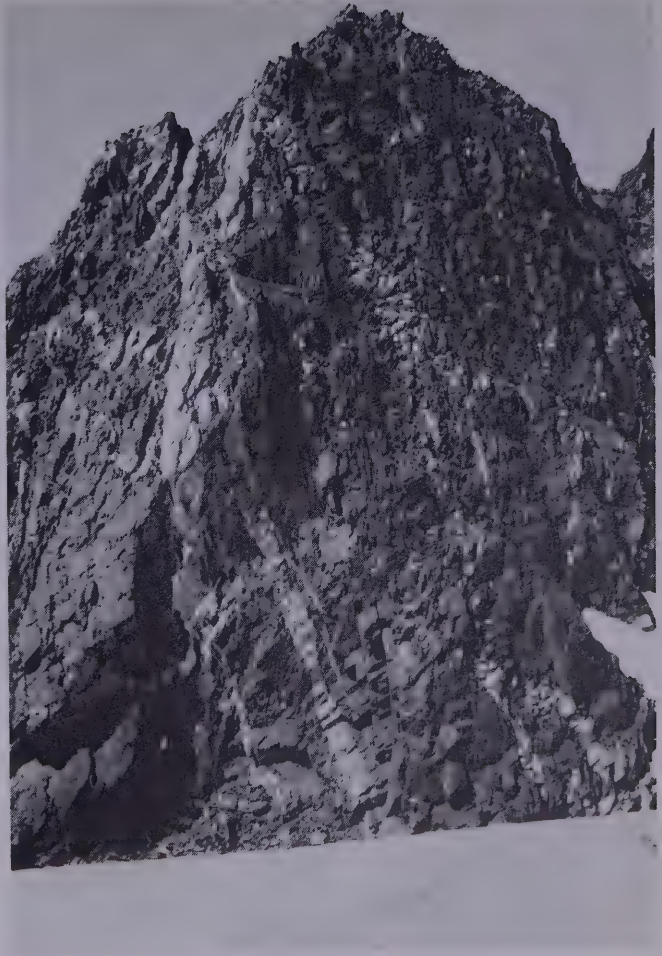

Plate III. B. Institute Peak: detail of pelitic series, of "Unit II", injected by granite veins.

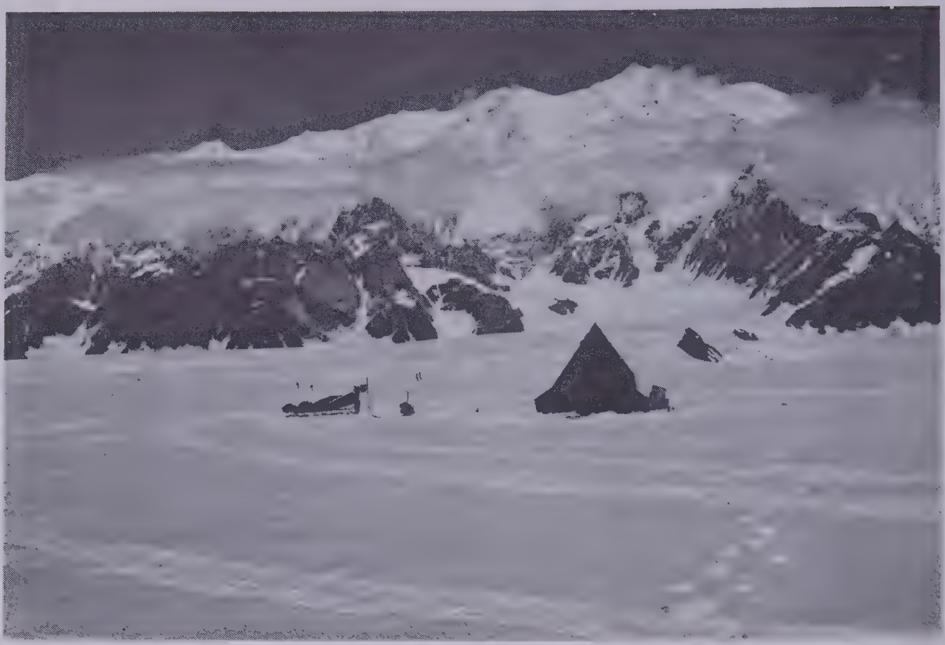

Plate IV. A. Mt. Logan (6054 m.), S. face, from Upper Seward firmfield. Lower rocks garnet-biotite-gneiss, with pegmatite and aplite intrusions.

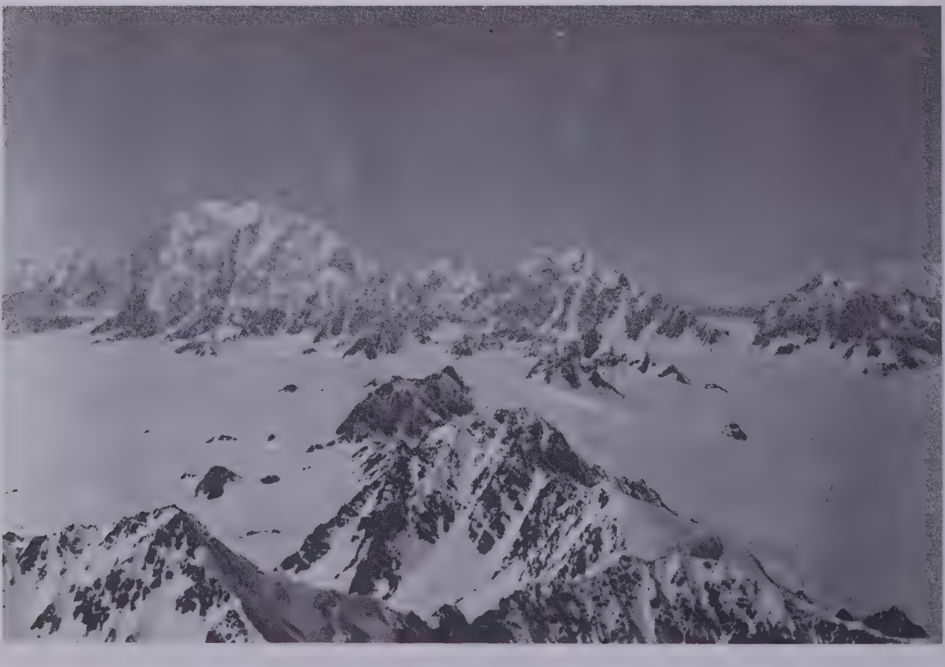

Plate IV. B. View N.W. from W. ridge of Mount Vancouver at 3660 m. Mt. Logan in left background, Mts. McArthur, King George, and Queen Mary to the right. Arctic and Institute Peaks in foreground.

As to the middle section of Mount Vancouver examined, in the vicinity of Camp I at about 275 m., and also above in the neighbourhood of a wide col (or saddle), which occurs in the great western spur of the mountain at approximately 4056 m., hornblende-schists, quartzose in part, and gneiss made their appearance. But sundry other lithological types occur: pelitic, calc and arkosic; and at the col itself small boulders of white and grey marble were much in evidence. The provenance of these latter is of some interest. As cited above, there are scattered calc beds of fairly pure marbles, that occupy no regular or determinable stratigraphical position within the pelites or other rocks, but which occur as conspicuous elongated or irregular masses, having suffered severe deformation during orogenesis (Odell (2) 1951, p.138; and Sharp and Rigsby, 1956, Plate 1 B.) From such outcrops, situated at a distance, the marble boulders may well have been derived, and have been carried as erratics to their present elevated position during an earlier and higher stand of the local inter-montane ice-sheet. As recorded elsewhere (Odell (3), 1951, p.39, 41; and Sharp and Rigsby, 1956, p.110) the latter, referred to as the Upper Seward Glacier, was proved seismically by the glaciological section of the Expedition to have a present thickness of some 610-1220 m. At its maximum during the Pleistocene, it must have been far thicker, and sundry U-shaped cols, situated at about 3355 m. in the St. Elias range, suggest that the former ice may well have drained through them at that level, if not higher. On the high wide saddle or col at 4056 m., on Mount Vancouver, apart from the marble boulders were other blocks forming together a band of moraine-like material, which lay longitudinally along the saddle, and with no steep ground or crags above from which they might have fallen, or slid, to indicate a purely local provenance.

Above the col steep snow and ice masked all rock outcrops as far as the actual summit of the mountain at ca. 4788 m. The restricted snow-crest of the latter and its flanking ice-slopes (enveloped during our ascent in thick mist) provided no bed-rock evidence, except at one spot about 610 m. down on the north side. Suspended on a rope by his companion, the writer managed, with some difficulty, to obtain a specimen from an extremely tough greenish grey rock. This rock has proved to be an interesting one, and unlike any other type found on the mountain or in the neighbourhood. It is clearly much altered material and specifically may be regarded as a greywacke, or perhaps, though less so, an arkose: the term meta-greywacke may be preferred (Dolar-Mantuani).

During the period of the writer's visiting appointment at the University of British Columbia, Dr. L. Dolar-Mantuani was good enough to make a detailed examination of this interesting rock, and the following notes are taken from her report. Megascopically the rock is greenish grey and very compact. The felsic minerals are in lenses in which quartz seems to predominate over feldspar. These lenses are cut by greenish epidote veinlets, up to 5 mm. long. There are medium-sized grains of brownish black biotite, and some prisms of dark amphibolite. The matrix is a greenish grey. Microscopically, the texture is typically porphyroblastic, and the heterogeneously distributed constituents show the following approximate amounts:—

Epidote	33%	Plagioclase	15%
Chlorite	20%	Biotite	8%
Quartz	18%	Hornblende	6%

Accessories 1% (magnetite; sphene or Fe-rich epidote; rare apatite, and carbonate)

That this rock appears to be polymetamorphic is indicated by its mineral composition, and by the cracks and veinlets in it. During the earlier period of regional metamorphism, which is considered to have had two phases, we have (1) the development of plagioclase, quartz[1], chlorite and epidote, and (2) the formation of clinozoisite, hornblende, and iron-rich epidote-sphene (?), with shearing effects on the plagioclase. This was followed by thermal metamorphism, with the formation of quartz[11], biotite and uralite; but the extent of its effects is difficult to determine. The absence of foliation would indicate that regional metamorphism had not played an important part. But the presence of cracks in some minerals shows that stress had probably been applied under conditions of low pressure, suggesting only a shallow depth prevailing at the time.

As to the origin of this interesting rock, the lack of sericite would seem to rule out arkose; and the more likely original formation would appear to have been a coarse-grained greywacke with appreciable amounts of calcareous cement. In his abstract earlier (1951) the writer had suggested that this rock might be regarded as the relic of a "roof-pendant", but on further consideration he would suspend judgement on this view. More will have to be known of the upper rocks of other peaks of this range.

In 1967, during the second ascent of Mount Vancouver (and after traversing from the lower S.S.E. summit) J.V. Hoeman* was able to collect a specimen (G.N.4) from an outcrop about 61 m. south of the main peak and 30 m. below it. This rock he kindly sent to the writer for examination. If its situation is correctly reported, it is in marked contrast to the greywacke described above. It is a compact greyish green rock, weathering brown, and in thin section shows much quartz, considerable hornblende laths (some chloritised), and scattered grains of garnet and iron ore. Though foliation is not marked, this rock can be described as a hornblende-gneiss, and it would seem to belong to the altered igneous type (meta-diorite) prevailing in this mountain mass, as stated above.

J.V. Hoeman also collected a few scattered specimens (three in all) from the lower S.S.E. summit (so-called "Good Neighbour Peak") of Mount Vancouver, and also from the S.E. buttress of the latter at about 2745 m. Two of these (G.N.1 and 2) consist of a biotite-granite, slightly foliated, with the mica showing evidence of strain and distortion†. The third specimen (G.N.3) is a hard compact chlorite-quartz-schist, which in thin section shows occasional veinlets of calcite. Owing to heavy snow cover on this flank of the mountain, no precise stratigraphical or structural relationship between the exposed outcrops could be determined.

It would seem clear, however, that this massif can be considered to be a part of the great sedimentary block of which the St. Elias Range is essentially formed, while locally it is intruded by bodies of granite or quartz-diorite. As to the problem of the actual late crustal movements, in which the whole series has been involved, reference is made below.

MOUNT LOGAN (6054.3 m.)

After his ascent of Mount Vancouver, the energetic Hoeman climbed Mount Logan (the highest elevation in Canada) by a new route over the long eastern ridge. From near its snowy summit, from the highest outcrop about 15.2 m. down on the S.E. side, he collected some small samples, and one of the latter he kindly sent me: "the highest rock in Canada", as he rightly described it. In thin section this proves to be a moderately fine-grained granite of a normal character, with coarse allotriomorphic quartz; much kaolinised orthoclase and oligoclase; some chloritised biotite, and sparsely scattered patches of pyrite. It may well be a part of the same granite intrusion found by the present writer in 1949 at the foot of the great south face of Mount Logan, where it had irrupted into gneisses (of the basement rocks). Now, it is of interest to mention that H.F. Lambart, who accompanied in 1925 the party

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*Hoeman died tragically in April 1969 in an avalanche on Dhaulagiri (8172 m.) in the Nepalese Himalaya.

†This granite would seem to be equivalent to that outcropping in the base of Institute Peak nearby, as cited earlier.

Recent re-determination by W. Wood, 5951 m. (19,525 ft.)

which pioneered the first ascent of Mount Logan, cites the highest rock outcrop at 5642.4 m. near the summit as being composed of a coarse-grained granitic type considered by him to be chiefly a "biotite-diorite gneiss"*.

When encamped on the western part of the névé of upper Seward Glacier at the southern foot of Mount Logan, the present writer examined sundry scattered outcrops (rognons, or rock-islands) extending right up to the foot of the mountain, and he found them to be composed essentially of granitic biotite-gneiss, much injected at places with pegmatite or aplite. Indeed it could clearly be seen that the immense 4270 m. southern wall of Logan consisted of similar rocks, including, moreover, massive dykes or sills lying within, or cutting across, the ruling foliation. From farther west again, from a few specimens brought back from the Quintino Sella Glacier in 1967 by Hoeman, quartz diorite and micaceous quartz schist prevail in that area.

In 1949 it was particularly unfortunate that persistent bad weather prevented the writer, together with Professor R.P. Sharp, from visiting the eastern end of the Mount Logan massif in order to examine the actual contact of the metamorphic series, gneisses and schists, with the fossiliferous beds (limy greywacke and limy quartzite, probably of lower Cretaceous age), which he and G.P. Rigsby had found in 1948. The fossil pelecypods (Aucellas) then collected would seem, as stated (Sharp and Rigsby, 1956, p.119), to represent the Berriasian of the very base of the Lower Cretaceous, and characterize, according to Imlay and Reeside (1954), the earliest Cretaceous of the Boreal region and the Pacific coast of North America. But Lower Cretaceous rocks are known in the Chitina valley, 125 miles to the north-west in Alaska, and also 65 miles to the east in Yukon, in the Dezadeash group. Moreoever, as cited by Sharp and Rigsby, the Yakutat group, of Cretaceous age, extending along the south face of the St. Elias Range, may include related rocks.

REGION NORTH OF MOUNT VANCOUVER

During an extensive and spectacular flight northward of Mount Logan and Vancouver, the writer was enabled to make a visual reconnaissance over that huge terrain of rugged mountain and glacier. From above the Seward-Hubbard divide it was evident that the metamorphic sediments, including probably orthogneisses, extended many miles to the north. In the north face of Logan itself, however, it was not possible to diagnose any specific or unusual structures. The sedimentaries, or at any rate bedded rocks, were seen to extend northward past Mounts Steele and Walsh, until in the neighbourhood of Wolf Creek schists, that had earlier been mapped by Sharp (Sharp, R.P., 1943) on its south side, could be discerned in contrast with the horizontal basalt sheets on the north side. But the unusual amount of snow on all these mountains for this time of the year made rock-observations and differentiations difficult.

It was clear that the zone of mountain deformation extended north and east as far at least as the basalts of Wolf Creek recorded by Sharp. But whether the movements and episodes within the St. Elias Range proper were contemporaneous with, or even similar to, those of the Lucania-Steele massif, remains to be ascertained. But the writer feels strongly that this mountainous terrain of the St. Elias and adjoining areas is just another example of differential uplift of discrete mountain masses, whatever may have been the initial horizontal forces and thrusting that brought about the folding within the ranges. In the Himalaya, for example, we see ample evidence of late vertical movements, often of the block type, that have created immense fault-scarps on the flanks of many mountain masses. As the writer has stated elsewhere (Odell (1), 1943) in describing these upstanding Himalayan massifs, "nothing else can explain the often fresh and unweathered mountain walls, which rise sheer to heights of 6000 to 10,000 ft. above their bases, and extend for many miles round the massifs." And no better examples of the same process in the St. Elias Range, it seems to me, could be cited than the great upstanding bulks of Mount Logan, of Mount Vancouver, and others, whose clean-cut walls rise thousands of feet abruptly above their bases, and when seen from the air make particularly impressive features.

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*Lambart, H.F., 1926, "The Conquest of Mount Logan", Nat.Geogr.Mag. Vol.49. p.597-631.

REGIONAL CONSIDERATIONS AND TECTONICS

Robert Stoneley (1967) has recently made a study of the bordering coastal area, and he emphasises the repeated oceanwards thrusting and folding of the Mesozoic and Kainozoic beds with dominant strike-slip faulting, and later deep underthrusting landwards. He postulates, or infers, the extension eastwards, into the St. Elias area, of a series of major faults, that are known in central and south-west Alaska. The chief of these are the Chugach-St. Elias fault, and the Chugach-Fairweather fault with its supposed dextral displacement. They are mapped as lying immediately to the south and south-west of Mount Vancouver and Mount Logan itself, and their traces are indicated as following the course of certain major glaciers. The Chitina-Artlewis fault is, however, inferred by Stoneley from topographical lineaments to N.W.-S.E., and, passing along the N.E. side of Mount Vancouver, to join the Fairweather fault. These features are out in the blank areas of his map, and indeed rather remote from the mapped coastal sedimentary formations, and the petroleum possibilities, in which his interests principally lay. Again, as Stoneley (1967) has emphasised, it is quite uncertain as to what extent the structure displayed in the Mesozoic rocks near Yakutat is of pre-Eocene age, or to what extent it may have been developed by later movements. That deformation may still be in progress is suggested by the earthquake activity taking place from time to time in this region.

It must be stressed, in as far as the character of the faulting is concerned, that C.A. Burk (1965) had emphasised the surprising lack of evidence for compressional folding and thrusting in this region, but rather the dominant vertical movements, as envisaged by the present writer. In his memoir on the geology of the Alaskan Peninsula and the eastern continuation of the Aleutian Chain island arc, Burk has traced the history of sedimentation, of movement and of plutonic intrusion, from early Jurassic times onwards; and he claims that there were five periods of deformation, three of which were associated with plutonic intrusion. But he says the Pliocene was the only period of strong orogenic movement in the area. The structures, he has shown, are almost entirely parallel to the Pacific Shelf edge, but that there is a surprising lack of compressional folding and thrusting. The whole area, he maintains, is characterised by differential vertical movement, following periods of plutonic intrusion; folding is gentle and reflects adjustment to the differential movements, while faulting is steep between structural units of block type. Burk found no evidence of transcurrent movement, and an absence of gently dipping thrusts, as has been claimed by Stoneley to exist in the region farther to the east. But apart from this striking contrast in interpretation, Burk's findings throw much doubt on the widely held concept of a major marginal thrust-belt, with the floor of the Pacific Ocean drifting under Alaska, or rotating relatively to the continental mass.

In referring to the disastrous Alaskan earthquake of the 27th March 1964, Burk states that while vast areas of the south coast of Alaska were uplifted, the only known bedrock displacement was reported on, and adjacent to, Montague Island in Prince William Sound, where movements of 50 ft. were recorded. The fault-planes are steep, and the relative movement is downthrown towards the (coastal) trench. Deformation in the Alaskan Peninsula is continuing, but this movement appears to be largely broad vertical uplift.

The author wishes to thank Doctors Sharp and Rigsby for the use of Figures 1 and 2. My thanks are also due to Dr. Dolar-Mantuani for her description of the summit specimen from Mount Vancouver.

REFERENCES

Burk, C.A., 1965, Geology of the Alaskan peninsular-island arc and continental margin: Geol. Soc. America, Mem. V.99, p.1-250.

Imlay, R.W. and Reeside, J.B., 1954, Correlation of the Cretaceous formations of Greenland and Alaska: Geol. Soc. America, Bull. V.65, p.223-246.

Odell, N.E. (1) 1943, The so-called "Axial Granite Core" of the Himalaya: its actual exposure in relation to its sedimentary cover: Geol. Mag. V.80, p.148-154.

Odell, N.E. (2) 1951, Notes on the geology of the St. Elias range, Alaska-Yukon Territory, North America: Geol. Soc. London Quart. Jour. V.106, p.137-139.

Odell, N.E. (3) 1951, The St. Elias Mountains and the first ascent of Mount Vancouver, Can. Geogr. Jour. V.43, p.36-48.

Sharp, R.P., 1943, Geology of the Wolf Creek area, St. Elias range, Yukon Territory, Canada: Geol. Soc. America Bull. V.54, p.625-650.

Sharp, R.P. and Rigsby, G.P., 1956, Some rocks of the central St. Elias mountains, Yukon Territory, Canada: Am. Journ. Sci., V.254, p.110-122.

Stoneley, R. 1967, The structural development of the Gulf of Alaska sedimentary province in southern Alaska: Geol. Soc, London Quart. Jour., V.123, p.25-27.

Stoneley, R. 1971, A note on the structural evolution of Alaska. Journ. Geol. Soc. V.127, p.623-628.

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